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THE GIDEON CRITERION: THE EFFECTS OF SELECTION CRITERIA ON SOLDIER CAPABILITIES AND BATTLE RESULTS

By

J. R. WALLACE

January 1982

Research, Studies and Evaluation Division
Program Analysis and Evaluation Directorate
Fort Sheridan, Illinois 60037

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This paper addresses the relationship between individual tank crewman mental aptitude and tank crew performance in gunnery skills. Additionally, the study uses combat simulation to establish correlations between battle results and individual tank crewmen mental aptitude. The findings clearly suggest a relationship between soldier mental aptitude and battle results and highlight the crucial need for the U. S. Army to recruit high-quality personnel.

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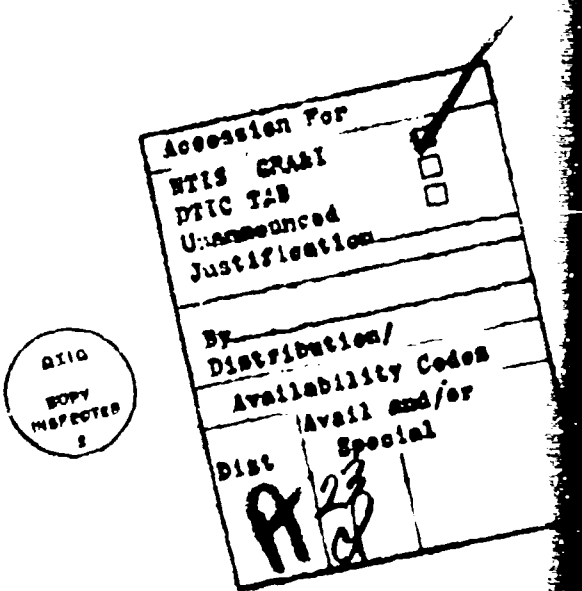
ABSTRACT

This paper addresses the relationship between mental aptitude of individual tank crewmen and tank crew gunnery performance. Additionally, the study uses combat simulation to establish correlations between battle results and individual tank crewmen mental aptitude . The findings suggest a strong relationship between soldier mental aptitude and battle results and highlight the need for the U.S. Army to recruit high-quality personnel.



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"The Lord said to Gideon: 'The people who are with you are too many for me to give Midian into their hands'... 'whoever is afraid and trembling, let him return and depart"... "then the Lord said to Gideon: 'the people are still too many. Bring them down to the water and I will test them for you there'... 'I will deliver you with the 300 men'... 'and will give the Midianites into your hand."

Judges 7:1-7 (RSV)

THE GIDEON CRITERION: THE EFFECTS OF SELECTION CRITERIA ON SOLDIER CAPABILITIES AND BATTLE RESULTS

THE PROBLEM

The relationship between soldier aptitude as measured by paper/pencil tests and weapons performance/battle results is the subject of considerable research and controversy. With the revelation that the U.S. Army inducted almost 50 percent mental category (MC) IV (eligible applicants who score less than 31 on the Armed Forces Qualification Test) recruits in FY 80, there has been increased concern about the effects that this large number of MC IV personnel will have on the combat performance of U.S. units. There have been many complex combat simulations performed that clearly establish that battle outcomes can be affected by changes in weapons system performance. To date, however, links between weapon system performance and soldier aptitudes have been less clearly defined.

The objective of this study is to determine if a statistically significant correlation between battle results and soldier aptitude exists. First, the correlation between mental aptitudes of soldiers (tank crewmen) and weapon system (tank) performance is determined. Then, using combat simulations, the effect of soldier aptitudes on battle results is demonstrated. This memorandum provides information on the study data, the analytical methodologies used in the study, and presents the results and conclusions derived from the analysis and combat simulations.

THE DATA

The data used in this analysis are the firing results from the 1981 Canadian Army Trophy (CAT) Competition held at Grafenwoehr, FRG in June 1981. The competition involved six NATO nations competing for a tank gunnery trophy donated by the Canadian Army in 1963. Each nation sent teams selected from operational tank battalions stationed in central Europe. Each national team consisted of five three-tank platoons that were required to negotiate a difficult battle run course.

The major reason USAREC selected the CAT competition as a source for study data was to avoid a classic problem in behavioral research, that is, restriction in the range of the test variables. Armed Forces Qualification Test (AFQT) percentile scores of participating crewmen ranged from 14 (MC V) to 93 (MC I), and crew performance ranged from poor to outstanding. With these ranges in the data, it was possible to establish valid correlations between individual crewman aptitude and crew performance.

Additionally, all crewmen had been intensely trained and were highly motivated. They were scored and judged under a rigid, uniform standard. Also, each nation was restricted in the amount of time and ammunition that could be expended in training each platoon. No main gun practice was allowed after 8 May 1981. As the competition took place June 15-19, 1981, the study is, in some ways, a measure of the retention of crew gunnery skills, also a valid concern in battle circumstances.

Finally, the competition provides a large data base. If all nations support the research, 90 sets of crew data would be available. Some problems do exist in attempting to correlate the other NATO participants' aptitude test scores to our AFQT score. Since this memorandum is concerned only with the performance of U.S. crews, those problems will not be addressed until the final study report is published. The advantages of the large data set are obvious, however.

THE ANALYSIS

Introduction

This section covers the disaggregation of firing results into data that could be analyzed, lists the relationships that were explored, and provides the results of relationships found to be significant.

The U.S. Seventh Army Training Command (7ATC) was responsible for hosting the CAT competition at Grafenwoehr Training Area. As part of their efforts to support the competition, six video tapes were made of each platoon battle run. Four cameras covered the downrange target area and two covered the firing tanks. USAREC obtained from 7ATC a set of the tapes and scoring sheets for each platoon.

The CAT scoring is aggregated into platoon results; no record is made of individual tank efforts. However, using the official scoresheets and the video tapes, it was possible to produce an accurate record of each crew's performance. The 21 performance variables computed for each tank crew are listed in table 1.

Table 1. Tank performance variables and abbreviations

	Variable	Abbreviation
1.	Percentage 1st round hits	P1R
2.	Percentage 2d round hits	P2R
3.	Percentage 3d round hits	P3R
4.	Percentage total hits	PT
5.	Percentage 1st round hits on moving targets	P1MT
6.	Percentage total hits on moving targets	PMT
7.	Percentage 1st round hits fired on the move	P1RS
8.	Percentage total hits fired on the move	PS
9.	Percentage 1st round hits at range $\geq$ 1600 m	P1R16
10.	Percentage 2d round hits at range $\geq$ 1600	P2R16
11.	Percentage total hits at ranges $\geq$ 1600 m	PT16
12.	Percentage 1st round hits at ranges $<$ 1600 m	P1LT16
13.	Percentage 2d round hits at ranges $<$ 1600 m	P2LT16
14.	Mean time to fire 1st round	MT1R
15.	Mean time between rounds	MTBR
16.	Minimum opening time	MINOT
17.	Maximum opening time	MAXOP
18.	Minimum time between targets	MINBT
19.	Maximum time between targets	MAXBT
20.	Total hits	TOTHIT
21.	Point score	SCORE

Other data obtained for this analysis were the U.S. Army Enlisted Master File (EMF) entries and the results of the pre-competition physical examinations administered to the U.S. team.

Objective

The objective of the analysis was to correlate the AFQT scores and physical exam findings (color blindness, vision acuity, etc.) of individual crewmen to tank performance. The AFQT composite was chosen because other NATO nations can produce a similar composite for their crewmen. Renormed AFQT scores* were used for all enlisted U.S. crewmen (officer AFQT scores are not available). All AFQT scores and physical results are, of course, restricted, but crew performance summaries can be found in appendix A.

A further explanation of the SCORE variable is required. As stated earlier, only platoon scores were computed during the competition. However, using the crew firing results compiled from the TV tapes, the scoring rules for the CAT competition could be applied to each tank. The scoring procedure awards 500 points for each main gun hit and 0 to 500 points for "time to hit", on a scale from 1 to 40 seconds (1 second = 500 points; 40 = 0 points). This scoring method was applied to each crew. Because the SCORE variable represents an accurate appraisal of total crew performance, (i.e., it measures the crew's ability to hit targets quickly), it seems appropriate to begin investigating relationships between the variables using SCORE as the response variable.

Results

To better understand the relationships between the variables, it is best to begin with a look at the plot of tank commander's (TC) AFQT versus SCORE. The original hypothesis was that the TC and gunner's (GR) AFQT score would correlate the highest with SCORE. A plot of TC AFQT and SCORE is shown in figure 1.

A linear relationship exists and it can be observed that all crews with TC AFQT's greater than 65 scored high, while those with TC AFQT below 30 scored low. Crews with TC AFQT percentiles between these ranges had mixed results. Table 2 contains the results of a linear regression of the 15 data points.

Table 2. TC AFQT regressed against SCORE (15 observations)

Slope	Intercept	Correlation	R2	MSE	F Test Significance (=)
35.59	1704.25	.59	.35	1729070	6.89 (.01)

* Because the people tested with the Armed Services Vocational Aptitude Battery tests 5, 6, and 7 administered between 1976 and 1980 were found to score higher than people with same aptitudes scored on previous versions of the tests, the results were subsequently renormed to provide correct scores. In all cases the renorming lowered the original AFQT score and therefore, the assigned mental category of soldiers who took ASVAB 5, 6, and 7.

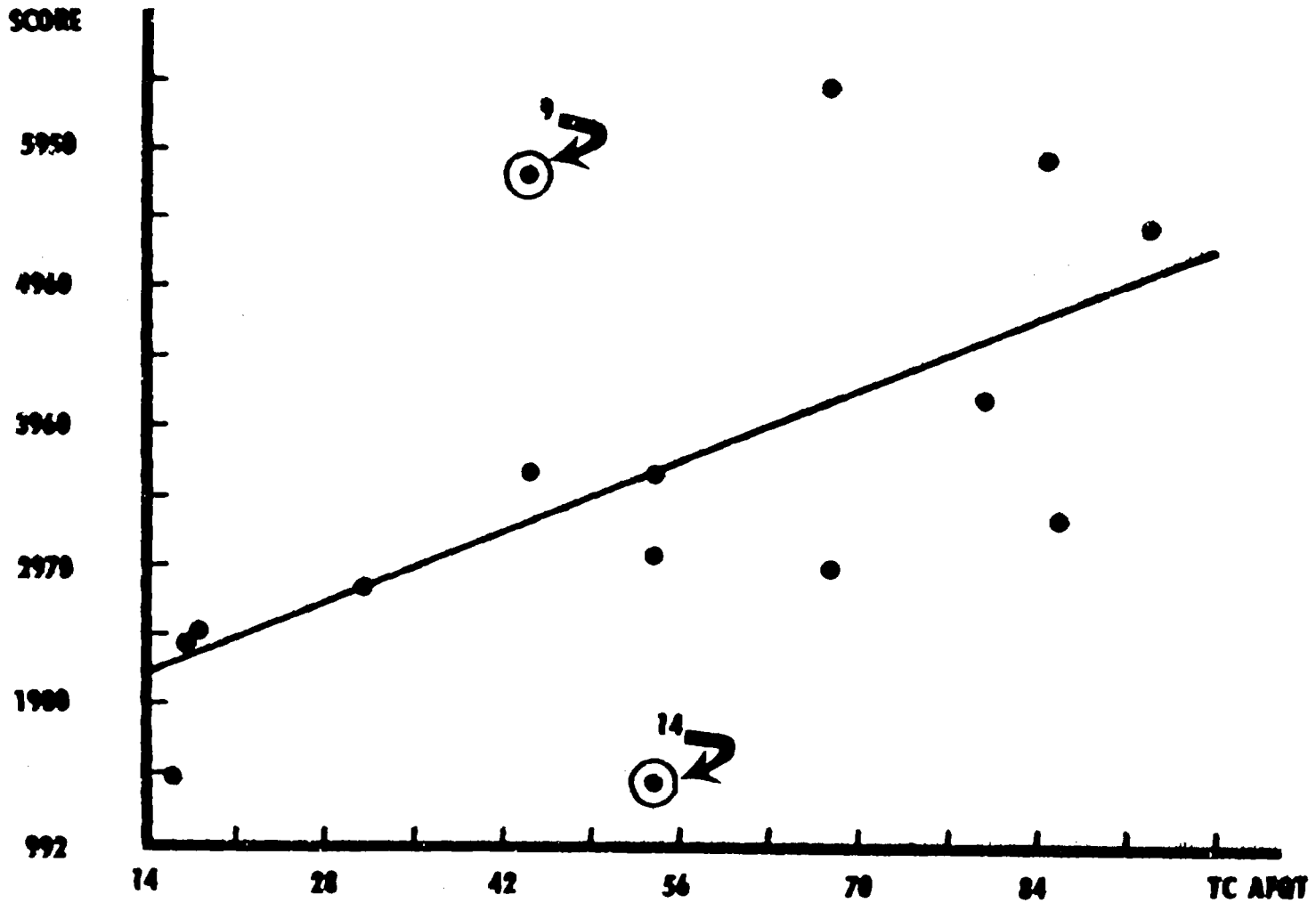

Figure 1. Tank commander APQT versus SCORE

There are two observations with fairly large residuals; 9 and 14. These observations are in the middle range (MC III) of the AFQT data. A regression with these points deleted shows that, while the intercept and slope of the regression line hardly change, the MSE of the equation is reduced by 40 percent and the R^2 is increased by 57 percent. These statistics indicate that these two points contribute heavily to the variance within the data. There are, as well, reasons to believe that these points are atypical observations (discussed in appendix B). A third regression was run using only nine data points, the three below AFQT 30 and the six above AFQT 65.

The regression line from these points almost duplicates the second equation, indicating that the relationship between variables is most strongly influenced by these nine observations.

Therefore, while analysis was conducted on both the 15 and 13 observation data sets (plus some smaller subsets), the 13 observations are believed to provide better estimates of the functional relationships between the variables. Table 3 shows that when using the smaller data set, only the precision (confidence intervals) of the estimates of the variable SCORE are improved, while only a minor change takes place in the coefficient values.

Table 3. TC AFQT regressed against SCORE (15, 13 and 9 observations)

No. of Obsv	Slope	Intercept	Correlation	R2	MSE	F Test Significance (≈)
15	35.59	1704.25	.59	.35	1729070	6.89 (.01)
13	38.25	1535.63	.74	.55	1029954	13.23 (.001)
9	38.9	1508.66	.74	.54	1545983	8.27 (.05)

The correlation matrices for TC, GR and loader (LR) AFQT scores with all 21 variables are in appendix C. With one exception, the only significant relationships found to exist were with TC AFQT scores. The GR AFQT was found to be correlated with variables PS and P1RS. Otherwise, the TC AFQT dominates the variance between crew performance.

The eight variables found to have the highest correlations with TC AFQT are listed in table 4.

Table 4. Variables highly correlated with TC AFQT

Variable	Slope	Intercept	Correlation	F Test Significance (≈)
P1R	.3839	36.83	.61	6.46 (.05)
P2R	.84	- 6.78	.48	2.65 (.10)
PT	.4963	28.27	.67	9.31 (.01)
P1R16	.6476	4.81	.44	2.66 (.10)
MINBT	-.0911	12.85	-.47	3.14 (.10)
P1LT16	.2015	54.93	.44	2.65 (.10)
TOTHIT	.0522	2.05	.77	15.92 (.001)
SCORE	38.28	1535.63	.74	13.23 (.001)

Other combinations of crew AFQT scores were explored to see if stronger correlations existed. Regression equations using independent variables both TC and GR AFQT scores, the mean of the GR and TC AFQT, and a weighted average of their scores failed to produce results better than those in table 4. However, a log-linear equation of the TC AFQT did produce superior results for some variables. Those are listed in table 5.

Table 5. Variables highly correlated with TC AFQT, log-linear form (13 observations)

Variable	Slope	Intercept	Correlation	F Test Significance (α)
ln (PIR)	.2918	2.89	.61	6.59 (.05)
ln (PT)	.4245	2.31	.68	9.66 (.05)
ln (TOTHIT)	.5171	-.4658	.82	23.29 (.001)
ln (SCORE)	.5019	6.19	.80	20.23 (.001)

This result indicates that the relationships for some variables may be slightly non-linear. This possibility needs to be explored with larger data sets. TC age and ability to bench press his body weight (taken from the physical exam data) were found to be insignificant predictors.

Conclusions of the Analysis

The conclusions can be simply stated. The tank commander dominated the performance of his tank in the NATO 1981 CAT tank gunnery competitions. His ability, as measured by AFQT, provided an accurate, statistically significant predictor of the gunnery performance of his tank. TC with high aptitude compensated (apparently) for GR with low aptitude while GR with high aptitude could not compensate for TC with low aptitude. The conclusion is intuitively appealing; the performance of a crew is highly correlated to the aptitude of their leader. However, it is acknowledged that the strength of the conclusion is weakened by the small sample size.

This finding should not be interpreted to mean that no relationships exist between the mental ability of the other crew members and the combat effectiveness of the tank. When considering the total tank combat effectivess, (maintenance, communications, tactics) statistically significant relationships could exist between the aptitude of all crew members and tank performance.

TANK BATTLE SIMULATION (BATTLE SIM)

Introduction

Although the analysis shows a relationship between TC AFQT and tank gunnery performance, it is necessary to demonstrate the effect of aptitude differences on combat effectiveness of the tank crews. As previously stated, many skills in addition to tank gunnery contribute to the combat effectiveness of tanks. In this study, combat effectiveness will be measured by the number of opposing vehicles killed by the crew in a combat simulation. Also, it is assumed that the crews perform their jobs at the standard effectiveness levels used in most of our war games and analyses, with one exception: for each simulation, tanks are commanded by soldiers with either high, standard, or low aptitude as measured by AFQT. Therefore, the simulation results provide an estimate of the differences in battle results attributable to the TC mental aptitude and provide insights and answers to the following questions:

- Is there a significant difference in combat effectiveness of a tank platoon with all MC II tank commanders and a tank platoon with all MC IV tank commanders?

- What increases in effectiveness can be expected by increasing the TC aptitudes to CAT MC I?

o Is the relationship between aptitude and battle results linear or non-linear?

o In short, should there be a "Gideon Criterion", that is, a practical selection criterion based on AFQT score for U.S. tank commanders?

Simulation Experimental Design

To answer these questions, a simple combat simulation was constructed using the General Purpose Simulation System (GPSS). The major assumptions incorporated in this model are discussed in appendix D. The GPSS code is listed in appendix E.

Essentially, the simulation portrays a Blue platoon of 5 tanks defending against a Red motorized rifle battalion (reinforced). Only direct-fire weapons are simulated; no artillery or infantry action is included. The simulation allows the Blue tanks to engage with main guns and the Red, in turn, to engage the Blue tanks with main guns and BMP-mounted Sagger anti-tank missiles.

To conduct the simulation, the levels of Blue and Red performance had to be established. From the previous analysis, it was determined that a Blue TC must have an AFQT score of 83 (MC II) for the Blue tanks to perform at the standard level of effectiveness used in our war games and simulations. This level of Blue performance was considered "base level" or "specification" (SPEC). Performance levels for TC with AFQT of 95 ( ) and 25(LOW) were the other two Blue levels of performance used in the analysis. Additionally, two levels of Red performance were assumed, one at specification (SPEC) and another at a level equivalent to our MC IV TC performance. The Red levels were included to test the effect of degradation of Red performance on the battle outcomes. There is no data to support the two Red levels. However, it is possible we may be overestimating the abilities of crewmen in Red tank forces. Of course, the level of Red aptitudes is a factor we cannot control,and estimates of Red performance should continue to be based on best available intelligence data. Three repetitions of the simulation were run for each combination of factors, making for a total of 18 repetitions.

Results of the Tank Battles

Table 6 contains the results of the number of mobility/firepower kills achieved by a Blue platoon (BMP and tank kills combined) and the results of the number of Blue tanks killed by the Red. Notice that when the Blue platoon is at SPEC (TC = MC II), the exchange ratio is 7.45 Red to 1 Blue. If the Blue platoon is at LOW (TC = MC IV), the mean exchange ratio is only 1.33 to 1, an 82 percent degradation in performance, as shown in figure 2. If the Red level is reduced to LOW while the Blue is maintained at SPEC, the exchange ratio is 11.5 Red to 1 U.S. Table 7 displays the ANOVA for the Blue kills while table 8 displays the results of Tukey's pairwise comparison of cell means. The results in tables 7 and 8 show that the most

significant factor in affecting the battle outcome is Blue performance. While there is no statistical difference between the HI and SPEC levels of Blue performance, the difference between these levels and LOW is dramatic. Table 9 shows that the number of Red kills on the Blue platoon is independent of both Red and Blue performance levels. Figure 3 shows a plot of TC AFQT against the mean M/F kills (3 simulations) for 6 TC AFQT level. The plot demonstrates a nonlinear relationship between these variables and that a diminishing returns effect is probably occurring around an AFQT score of 65 (MC II).

Discussion of the Battle Results

The results indicate that, under the conditions assumed in the simulation, tank platoons with MC I and MC II tank commanders stand a good chance of destroying, or at least decimating, an attacking Soviet MR battalion; tank platoons with CAT IV commanders will likely be destroyed, leaving the Soviet formation intact. While BATTLE SIM results show no advantage from increasing TC aptitude from MC II to MC I, they demonstrate an astounding increase in effectiveness that can be expected when MC IV commanders are replaced by MC II commanders. The results suggest that the outcome of tank battles could hinge more on the quality of people than on material, and that efforts to recruit high aptitude soldiers may have a greater return in combat effectiveness than equivalent resources spent on hardware.

Persons who would argue that more or better training can make up for aptitude deficiencies are reminded that the crews participating in the CAT competition were probably the most intensively trained tank crews in the U.S. Army in 1981. No tank battalion under normal circumstances can begin to approach the intensity and thoroughness of training given these crewmen: time, range, and ammunition resources are just not there. We must consider these crews, then, to represent the upper range of U.S. tank crew performance (at the current time) and, therefore, the results of the battle simulations a "best" case.

Conclusions

This study has demonstrated that a significant relationship exists between tank commander AFQT and the performance of his tank. Additionally, a significant relationship between TC AFQT and expected battle results has been established. It suggests that a "Gideon Criterion," (perhaps an AFQT score equal to or greater than 65) for tank commanders could dramatically improve the combat effectiveness of the tank force. As a minimum, it is apparent that MC IV tank commanders can cause serious degradation of the effectiveness of tank units. Although the cost and difficulty of recruiting personnel with higher mental aptitude is significant, the consequences of not recruiting them could be more significant. If our efforts "to train to fight and win outnumbered" are to be taken seriously, the manpower quality of our tank force must be improved.

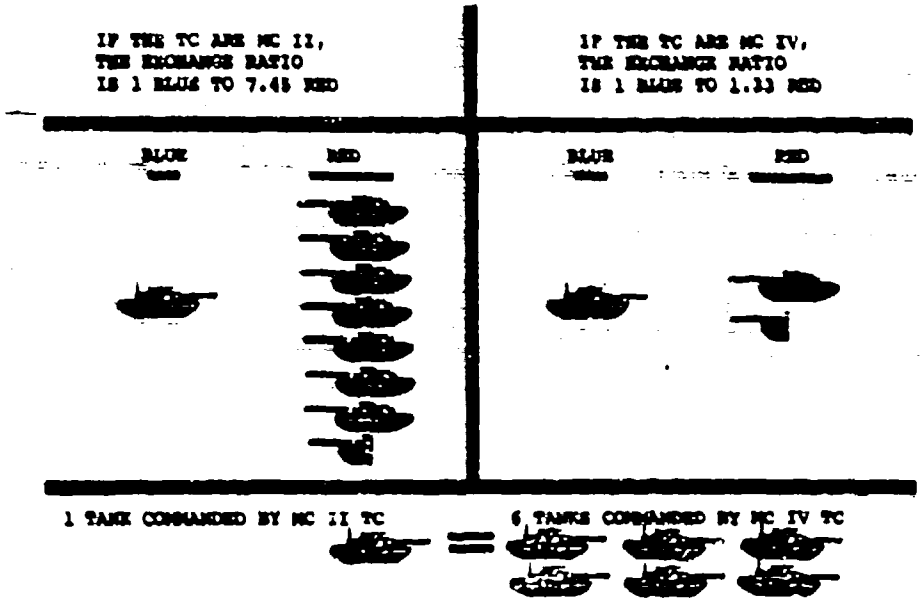

FIGURE 2. COMPARISON OF SIMULATED BATTLE RESULTS OF BLUE TANKS WITH MC II VERSUS MC IV TANK COMMANDERS

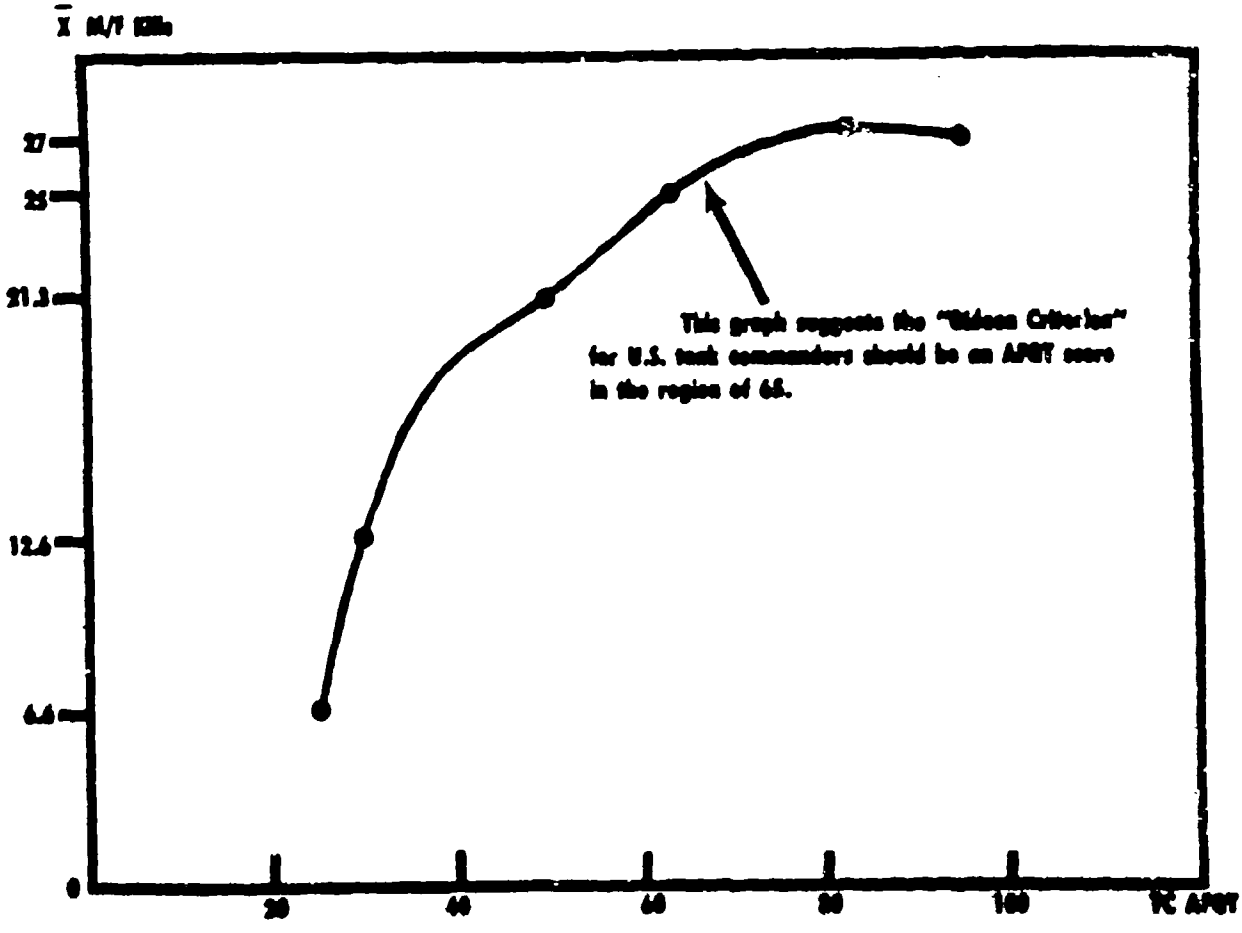

FIGURE 3. TC AFQT VERSUS MEAN NUMBER OF M/F KILLS PER PLATOON

Table 6. Results of the battle simulations

	Blue M/F* Kills on Attacking Red				Red M/F Kills on Defending Blue			
	Blue				Blue			
Red	SPEC	HI	LOW	$Y_{i..}$	SPEC	HI	LOW	$Y_{i..}$
SPEC	17 24(82) 41	31 33(81) 17	2 9(20) 9	183	5 5(11) 1	4 4(13) 5	5 5(15) 5	39
LOW	37 26(104) 41	37 26(96) 33	30 34(98) 34	298	3 5(9) 1	3 5(13) 5	4 3(10) 3	32
$Y_{.j.}$	186	177	118	481 =Y...	20	26	25	71 =Y...

* Mobility/Firepower

Table 7. Analysis of variance for blue kills

Source	DF	SS	MS	F_0
Blue	2	454.78	227.39	6.93*
Red	1	738.72	734.72	22.39*
Blue(Red)	2	394.44	198.72	6.06***
Error	12	393.67	32.8	
TOTAL:	17			

* Significant at .01 level.
*** Signficant at .05 level.

Table 8. Pairwise comparison of cell means, α = .01**

	spec/-*	-/-	+ /-	spec/spec	+/spec	-/spec
spec/-	-	2	2.6	7.3	7.6	28**
-/-		-	0.6	5.3	5.6	26**
+/-			-	4.7	5	25.4**
spec/spec				-	.3	20.7**
+/spec					-	20.4**
-/spec						-

* HIGH = +
LOW = -

Table 9. Analysis of variance for Red kills

Source	DF	SS	MS	F_0
Blue	2	3.445	1.772	.911
Red	1	2.722	2.722	1.44
Blue(Red)	2	2.111	1.055	.558
Error	12	22.667	1.889	
Total:	17			

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APPENDIX A - DATA SUMMARIES

Table A-1. Summary of 1981 U.S. CAT crew performance

NATION	PLATOON	CREW	PERCENT FIRST ROUND HITS	PERCENT SECOND ROUND HITS	PERCENT THIRD ROUND HITS	PERCENT TOTAL	PERCENT MOVING TARGETS	PERCENT FIRST ROUND MOVING TARGETS	PERCENT STAB
US	1	A	63	0	9999	30	20	33	100
US	1	B	29	0	9999	22	9999	9999	100
US	1	C	44	0	9999	40	9999	9999	100
US	2	A	55	0	9999	55	0	0	0
US	2	B	50	0	9999	44	33	50	50
US	2	C	62	100	9999	66	100	100	9999
US	3	A	57	33	9999	50	100	100	100
US	3	B	44	100	9999	50	50	50	0
US	3	C	77	100	9999	80	0	0	100
US	4	A	60	9999	9999	60	0	0	9999
US	4	B	57	0	9999	50	0	0	0
US	4	C	89	9999	9999	88	9999	9999	100
US	5	A	75	100	9999	78	100	100	50
US	5	B	20	0	9999	20	0	0	0
US	5	C	88	100	9999	89	100	100	0

PERCENT FIRST ROUND STAB	PERCENT FIRST ROUND =) 1600 METERS	PERCENT SECOND ROUND =) 1600 METES	PERCENT TOTAL ROUNDS =) 1600 METERS	MEAN TIME FIRST ROUND	MEAN TIME BETWEEN ROUNDS	MINIMUM OPENING TIME	MAXIMUM OPENING TIME	MINIMUM TIME BETWEEN ROUNDS
100	25	0	17	10	11	6	15	9
100	0	0	0	19	23	8	35	5
100	0	0	0	17	15	7	37	9
0	0	9999	0	13	23	7	27	2
50	50	0	33	13	9	4	31	5
9999	33	100	50	10	12	5	17	3
100	0	9999	0	11	9	7	16	23
0	0	9999	0	7	8	5	5	6
100	100	100	100	15	11	4	33	1
9999	50	9999	50	8	9999	7	10	11
0	67	9999	67	9	7	5	13	11
100	100	9999	100	8	9999	5	10	6
50	100	9999	100	15	9	6	38	4
0	25	0	20	13	13	7	20	1
0	100	9999	100	14	10	5	31	8

MAXIMUM TIME BETWEEN ROUNDS	PERCENT FIRST ROUND < 1600 METERS	PERCENT SECOND ROUND < 1600 METERS	TYPE TANK	TOTAL HITS	SCORE
11	67	0	1	3	2476
16	50	9999	1	2	1445
19	67	9999	1	4	2934
12	63	0	1	5	3284
9	50	9999	1	4	3613
13	80	9999	1	6	4130
23	44	33	1	5	2789
16	57	100	1	5	3632
12	67	9999	1	8	5753
17	67	9999	1	3	2393
12	50	0	1	4	3029
9	88	9999	1	8	6372
10	67	100	1	7	5353
7	33	0	1	2	1410
21	86	100	1	8	9847

Table A-2. Summary of U.S. statistics, 15 observations

VARIABLE	MEAN	STANDARD DEV	CASES
AFQT	54.1333	25.9281	15
NATION	.0001	0.	15
PLATOON	3.0000	1.4439	15
CREW	.0000	.0000	15
JOB	.0000	0.	15
P1R	57.2000	18.8119	15
P2R	41.0000	49.3592	13
PT	54.8000	22.2075	15
PMT	41.9167	45.6318	12
P1MT	44.4167	45.1411	12
PS	53.8462	47.7037	13
P1RS	53.8462	47.7037	13
P1R16	43.3333	41.1108	15
P2R16	28.5714	48.7950	7
PT16	42.4667	41.5896	15
MTIR	12.1333	3.5227	15
MTBR	12.3077	5.2023	13
MINOT	5.8667	1.2459	15
MAXOP	22.5333	11.1026	15
MINBT	6.9333	5.5352	15
MAXBT	13.8000	4.6935	15
P1LT16	63.8667	14.5498	15
P2LT16	41.6250	49.6097	8
TOTHIT	4.9333	2.0862	15
SCORE	3630.6667	1567.4575	15

Table A-3. Summary of U.S. statistics, 13 observations

variable	mean	standard dev	cases
afqt	54.9231	27.8402	13
nation	.0001	0.	13
platoon	2.8462	1.4632	13
crew	.0000	.0000	13
job	.0000	0.	13
p1r	57.9231	17.5664	13
p2r	39.3636	49.0352	11
pt	55.5385	20.5167	13
pmt	50.3000	45.5681	10
p1mt	53.3000	44.3222	10
ps	54.5455	47.1940	11
p1rs	54.5455	47.1940	11
p1r16	40.3846	40.8259	13
p2r16	20.0000	44.7214	5
pt16	39.7692	41.1363	13
mtir	11.8462	3.6934	13
mtbr	12.3636	5.6793	11
minot	5.9231	1.1875	13
maxop	21.9231	11.5648	13
minbt	7.0462	5.3828	13
maxbt	14.4615	4.3938	13
p1lt16	66.0000	12.7214	13
p2lt16	47.5714	50.4112	7
tothit	4.9231	1.8913	13
score	3638.2308	1442.2355	13

APPENDIX B

DISCUSSION OF OBSERVATIONS 9 AND 14

The deletion of data points 9 and 14 is supported in this discussion. Observation 14 represents a crew commanded by an officer. Since AFQT scores do not exist for officers, the mean TC AFQT score of the Blue crews was substituted for the officer scores. Therefore, exact placement of this observation cannot be made. Additionally, the extremely poor performance of the tank (all misses were "short-line") creates suspicion that the tank had some undetected mechanical error or had been improperly zeroed. Of course, the observation may be valid and, if it is, could say a lot about the proficiency of Blue officer tank commanders. In fact, none of the Blue officer crews excelled in the competition. Therefore, factors may be at work among officer performance that are not apparent in the other observations. The most appealing consideration is that the officer's were relatively young and inexperienced, although age was found to be an insignificant factor. For these reasons, observation 14 was considered to be atypical.

Observation 9 is the opposite case. This individual represented an NCO whose AFQT was a low 3B. Additionally, his gunner had a low AFQT. It was interesting to read in the CAT team captain's after action report, that he observed a relationship between GT score and performance in training (see appendix F). He noted that, with one exception, TC with a low GT score had less interest in, motivation for and grasp of the CAT gunnery requirements than their higher scoring counterparts. I suspect, but cannot prove, that observation 9 was this TC and that he is atypical of his AFQT percentile. In a very small sample size, it is disadvantageous to include observations that are atypical and could, therefore, produce erroneous analysis conclusions. For these reasons, however, observation 9 was deleted from the further analysis.

APPENDIX C

CORRELATION MATRICES

Table C-1. TC correlation matrix, 13 observations

	afqt	mation	platoon	crew	job	plr	p2r	pt	mat	plat	ps	plrs
afqt	13.	13.	13.	13.	13.	13.	11.	13.	10.	10.	11.	11.
mation	99.00000	13.	13.	13.	13.	13.	11.	13.	10.	10.	11.	11.
platoon	.36995	99.00000	13.	13.	13.	13.	11.	13.	10.	10.	11.	11.
crew	.44231	99.00000	.02821	13.	13.	13.	11.	13.	10.	10.	11.	11.
job	99.00000	99.00000	99.00000	99.00000	13.	13.	11.	13.	10.	10.	11.	11.
plr	.60848	99.00000	.80678	.37280	99.00000	13.	11.	13.	10.	10.	11.	11.
p2r	.47700	99.00000	.62131	.30705	99.00000	.62909	11.	11.	9.	9.	10.	10.
pt	.67353	99.00000	.81632	.39461	99.00000	.97079	.76411	13.	10.	10.	11.	11.
mat	.42213	99.00000	.31442	.46905	99.00000	.56584	.78624	.56497	10.	10.	8.	8.
plat	.38740	99.00000	.23911	.46129	99.00000	.51522	.73790	.51622	.99026	10.	8.	8.
ps	-.48931	99.00000	-.44985	.06932	99.00000	-.21744	-.41750	-.32627	.25786	.34591	11.	11.
plrs	-.48931	99.00000	-.44985	.06932	99.00000	-.21744	-.41750	-.32627	.25786	.34591	1.00000	11.
plr16	.44162	99.00000	.78785	.26450	99.00000	.84016	.43644	.77803	.25988	.26062	-.19541	-.19541
p2r16	.63069	99.00000	.61237	.58333	99.00000	.76585	1.00000	.85707	.98847	.96976	99.00000	99.00000
pt16	.49195	99.00000	.80235	.33277	99.00000	.87112	.53601	.82927	.34365	.32292	-.20795	-.20795
mtlr	.16358	99.00000	-.32856	.09473	99.00000	-.26865	-.26668	-.28365	.40781	.43902	.27041	.27041
mtbr	-.04507	99.00000	-.55755	-.03840	99.00000	-.42281	-.41526	-.37289	-.32870	-.36249	.19691	.19691
minot	-.37828	99.00000	-.34308	-.36515	99.00000	-.43174	-.38020	-.43253	-.14984	-.21322	.44173	.44173
maxop	.38460	99.00000	-.16819	.10098	99.00000	-.07797	-.14544	-.08937	.35466	.39100	.12074	.12074
minbt	-.47164	99.00000	.12371	-.24442	99.00000	-.03010	-.17177	-.13954	.12632	.11381	.32142	.32142
maxbt	-.22189	99.00000	.03624	.10619	99.00000	-.08524	.16759	-.06563	.39985	.33884	.05648	.05648
plt16	.44094	99.00000	.36710	.57405	99.00000	.77229	.60226	.75894	.61214	.57759	.14008	.14008
p2lt16	.40933	99.00000	.67372	.48177	99.00000	.53676	1.00000	.70698	.75007	.72628	-.24976	-.24976
tothit	.76906	99.00000	.65785	.48201	99.00000	.89528	.80403	.92033	.78691	.74301	-.27174	-.27174
score	.73899	99.00000	.66078	.50441	99.00000	.89911	.76651	.91116	.67913	.66368	-.24268	-.24268

	plr16	p2r16	pt16	mtlr	mtbr	minot	maxop	minbt	maxbt	plt16	p2lt16	tothit
afqt	13.	5.	13.	13.	11.	[illegible]	13.	13.	13.	13.	7.	13.
mation	13.	5.	13.	13.	11.	[illegible]	13.	13.	13.	13.	7.	13.
platoon	13.	5.	13.	13.	11.	[illegible]	13.	13.	13.	13.	7.	13.
crew	13.	5.	13.	13.	11.	[illegible]	13.	13.	13.	13.	7.	13.
job	13.	5.	13.	13.	11.	13.	13.	13.	13.	13.	7.	13.
plr	13.	5.	13.	13.	11.	13.	13.	13.	13.	13.	7.	13.
p2r	11.	5.	11.	11.	11.	11.	11.	11.	11.	11.	7.	11.
pt	13.	5.	13.	13.	11.	13.	13.	13.	13.	13.	7.	13.
mat	10.	3.	10.	10.	9.	10.	10.	10.	10.	10.	7.	10.
plat	10.	3.	10.	10.	9.	10.	10.	10.	10.	10.	7.	10.
ps	11.	4.	11.	11.	10.	11.	11.	11.	11.	11.	7.	11.
plrs	11.	4.	11.	11.	10.	11.	11.	11.	11.	11.	7.	11.
plr16	13.	5.	13.	13.	11.	13.	13.	13.	13.	13.	7.	13.
p2r16	.29386	5.	5.	5.	5.	5.	5.	5.	5.	5.	1.	5.
pt16	.98422	.77398	13.	13.	11.	13.	13.	13.	13.	13.	7.	13.
mtlr	-.15819	-.51982	-.17687	13.	11.	13.	13.	13.	13.	13.	7.	13.
mtbr	-.56591	-.20412	-.47955	.61256	11.	11.	11.	11.	11.	11.	7.	11.
minot	-.53218	-.35355	-.50021	.47207	.72627	13.	13.	13.	13.	13.	7.	13.
maxop	.04366	-.34297	.01135	.94399	.43710	.26652	13.	13.	13.	13.	7.	13.
minbt	-.17376	-.66667	-.18872	-.19830	-.38655	.29569	-.29739	13.	13.	13.	7.	13.
maxbt	-.34850	-.08436	-.30367	.18626	.01171	.43477	.03994	.63669	13.	13.	7.	13.
plt16	.47574	.74922	.55209	-.19865	-.11517	-.17652	-.12008	-.03529	.12121	13.	7.	13.
p2lt16	.43503	99.00000	.45648	.23597	-.40426	-.43885	.29396	-.21048	.29707	.44136	7.	7.
tothit	.65445	.82916	.70241	-.16886	-.38123	-.48520	.00733	-.15679	-.06272	.75161	.78536	13.
score	.77638	.65129	.79592	-.18142	-.45337	-.59884	.02368	-.28082	-.24298	.70932	.80617	.96182

Table C-2. TC correlation matrix, 15 observations

	AFQT	NATION	PLATOON	CREW	JOB	P1R	P2R	PT	PMT	P1MT	PS	P1RS
AFQT	15.	15.	15.	15.	15.	15.	13.	15.	12.	12.	13.	13.
NATION	99.00000	15.	15.	15.	15.	15.	13.	15.	12.	12.	13.	13.
PLATOON	.33687	99.00000	15.	15.	15.	15.	13.	15.	12.	12.	13.	13.
CREW	.37201	99.00000	0.	15.	15.	15.	13.	15.	12.	12.	13.	13.
JOB	99.00000	99.00000	99.00000	99.00000	15.	15.	13.	15.	12.	12.	13.	13.
P1R	.49521	99.00000	.49024	.42352	99.00000	15.	13.	15.	12.	12.	13.	13.
P2R	.38517	99.00000	.42455	.40903	99.00000	.69924	13.	13.	11.	11.	12.	12.
PT	.54253	99.00000	.48998	.44597	99.00000	.97810	.80182	15.	12.	12.	13.	13.
PMT	.42370	99.00000	.14867	.22183	99.00000	.45327	.60484	.46188	12.	12.	10.	10.
P1MT	.39006	99.00000	.07533	.19907	99.00000	.41760	.55132	.41287	.99161	12.	10.	10.
PS	-.46926	99.00000	-.51463	.18803	99.00000	.04480	-.13277	-.02780	.13777	.19172	13.	13.
P1RS	-.46926	99.00000	-.51463	.18803	99.00000	.04480	-.13277	-.02780	.13777	.19172	1.00000	13.
P1R16	.36329	99.00000	.62381	.36921	99.00000	.81831	.52804	.77127	.12280	.11377	-.02095	-.02095
P2R16	.40784	99.00000	.16667	.70065	99.00000	.85502	1.00000	.90511	.42930	.29471	.29277	.29277
PT16	.60758	99.00000	.63355	.42660	99.00000	.85122	.61371	.82011	.19728	.17090	-.02205	-.02205
MT1R	.13274	99.00000	-.26318	.16230	99.00000	-.19445	-.17310	-.19959	.14279	.14880	.28212	.28212
MTBR	-.03499	99.00000	-.48911	-.06700	99.00000	-.39129	-.40988	-.34984	-.33410	-.35890	.14040	.14040
MINOT	-.28906	99.00000	-.19582	-.45887	99.00000	-.54123	-.50740	-.54831	-.08339	-.12615	.14686	.14686
MAXOP	.34091	99.00000	-.16701	.18605	99.00000	.02921	-.01742	.02654	.19993	.21800	.20285	.20285
MINBT	-.38715	99.00000	-.01763	-.29654	99.00000	.02072	-.17545	-.06927	.29791	.29854	.27454	.27454
MAXBT	-.18466	99.00000	-.12476	.07073	99.00000	.07006	.18977	.08457	.49217	.45069	.14719	.14719
P1LT16	.35374	99.00000	.05366	.48168	99.00000	.79710	.60238	.78491	.59323	.57649	.31424	.31424
P2LT16	.40492	99.00000	.44474	.41799	99.00000	.60747	1.00000	.73761	.78212	.76233	-.13241	-.13241
TOTHIT	.60100	99.00000	.37422	.53925	99.00000	.91584	.83163	.93707	.53731	.49883	.04043	.04043
SCORE	.58865	99.00000	.38218	.55149	99.00000	.92119	.80431	.93236	.46913	.45173	.04663	.04663

	P1R16	P2R16	PT16	MT1R	MTBR	MINOT	MAXOP	MINBT	MAXBT	P1LT16	P2LT16	TOTHIT
AFQT	15.	7.	15.	15.	13.	15.	15.	15.	15.	15.	8.	15.
NATION	15.	7.	15.	15.	13.	15.	15.	15.	15.	15.	8.	15.
PLATOON	15.	7.	15.	15.	13.	15.	15.	15.	15.	15.	8.	15.
CREW	15.	7.	15.	15.	13.	15.	15.	15.	15.	15.	8.	15.
JOB	15.	7.	15.	15.	13.	15.	15.	15.	15.	15.	8.	15.
P1R	15.	7.	15.	15.	13.	15.	15.	15.	15.	15.	8.	15.
P2R	13.	7.	13.	13.	13.	13.	13.	13.	13.	13.	8.	13.
PT	15.	7.	15.	15.	13.	15.	15.	15.	15.	15.	8.	15.
PMT	12.	5.	12.	12.	11.	12.	12.	12.	12.	12.	8.	12.
P1MT	12.	5.	12.	12.	11.	12.	12.	12.	12.	12.	8.	12.
PS	13.	6.	13.	13.	12.	13.	13.	13.	13.	13.	8.	13.
P1RS	13.	6.	13.	13.	12.	13.	13.	13.	13.	13.	8.	13.
P1R16	15.	7.	15.	15.	13.	15.	15.	15.	15.	15.	8.	15.
P2R16	.66036	7.	7.	7.	7.	7.	7.	7.	7.	7.	2.	7.
PT16	.98637	.84963	15.	15.	13.	15.	15.	15.	15.	15.	8.	15.
MT1R	-.06346	-.27367	-.08139	15.	13.	15.	15.	15.	15.	15.	8.	15.
MTBR	-.48491	-.28556	-.45739	.58378	13.	13.	13.	13.	13.	13.	8.	13.
MINOT	-.61125	-.58916	-.59006	.32982	.67043	15.	15.	15.	15.	15.	8.	15.
MAXOP	.14244	-.13776	.11529	.93860	.39850	.10878	15.	15.	15.	15.	8.	15.
MINBT	-.22621	-.35311	-.23008	-.26493	-.33613	.24719	-.32134	15.	15.	15.	8.	15.
MAXBT	-.29124	.01197	-.24246	.10541	.00438	.30048	.02550	.68132	15.	15.	8.	15.
P1LT16	.43308	.62641	.50355	-.19195	-.11889	-.28080	-.05215	.14268	.32174	15.	8.	15.
P2LT16	.45163	99.00000	.47946	.14105	-.42371	-.51943	.28445	-.04336	.41316	.53006	8.	8.
TOTHIT	.69485	.88999	.73965	-.07646	-.34860	-.60621	.12808	-.12412	.05620	.74564	.79589	15.
SCORE	.78618	.80891	.80904	-.09657	-.40576	-.68689	.13347	-.20983	-.07740	.72528	.81679	.97209

Table C-3. GR correlation matrix, 13 observations

	afqt	natioa	platoon	crew	job	p1r	p2r	pt	mat	plat	ps	p1rs
afqt	13.	13.	13.	13.	13.	13.	11.	13.	10.	10.	11.	11.
natioa	99.00000	13.	13.	13.	13.	13.	11.	13.	10.	10.	11.	11.
platoon	.04404	99.00000	13.	13.	13.	13.	11.	13.	10.	10.	11.	11.
crew	.15971	99.00000	.02021	13.	13.	13.	11.	13.	10.	10.	11.	11.
job	99.00000	99.00000	99.00000	99.00000	13.	13.	11.	13.	10.	10.	11.	11.
p1r	.18385	99.00000	.80678	.37280	99.00000	13.	11.	13.	10.	10.	11.	11.
p2r	-.28158	99.00000	.62131	.30705	99.00000	.62909	11.	11.	9.	9.	10.	10.
pt	.14107	99.00000	.81632	.39461	99.00000	.97079	.76411	13.	10.	10.	11.	11.
mat	.00823	99.00000	.31442	.44905	99.00000	.56584	.78624	.58497	10.	10.	8.	8.
plat	.02640	99.00000	.23911	.46129	99.00000	.51522	.73790	.51622	.99026	10.	8.	8.
ps	.50727	99.00000	-.46985	.06932	99.00000	-.21744	-.41750	-.32627	.25786	.34591	11.	11.
p1rs	.50727	99.00000	-.46985	.06932	99.00000	-.21744	-.41750	-.32627	.25786	.34591	1.00000	11.
p1r16	.00848	99.00000	.78785	.26650	99.00000	.84016	.43644	.77803	.25988	.26062	-.19541	-.19541
p2r16	-.39658	99.00000	.61237	.58333	99.00000	.76585	1.00000	.85707	.98647	.96976	99.00000	99.00000
pt16	.04839	99.00000	.80235	.33277	99.00000	.87112	.53601	.82927	.34365	.32292	-.20795	-.20795
mtlr	.10927	99.00000	-.32856	.09473	99.00000	-.26865	-.26668	-.28365	.40781	.43902	.27041	.27041
mtbr	-.07437	99.00000	-.55755	-.03840	99.00000	-.42281	-.41526	-.37289	-.32870	-.36249	.19691	.19691
minmt	.13552	99.00000	-.34308	-.36515	99.00000	-.43174	-.38020	-.43253	-.16984	-.21322	.44173	.44173
maxmp	.17609	99.00000	-.16819	.10098	99.00000	-.07797	-.14544	-.08937	.35446	.39100	.12074	.12074
minbt	.27538	99.00000	.12371	-.24442	99.00000	-.03010	-.17177	-.13954	.12832	.11381	.32142	.32142
maxbt	.05665	99.00000	.03624	.10619	99.00000	-.08524	.16759	-.06563	.39985	.33884	.05648	.05648
p11t16	.15418	99.00000	.36710	.57405	99.00000	.77229	.60226	.75894	.61214	.57759	.14008	.14008
p21t16	.05498	99.00000	.67372	.48177	99.00000	.53676	1.00000	.70698	.75007	.72628	-.24976	-.24976
totmit	.11318	99.00000	.65785	.48201	99.00000	.89528	.80403	.92033	.78691	.74301	-.27174	-.27174
score	.15563	99.00000	.66078	.50441	99.00000	.89911	.76651	.91116	.67913	.66368	-.24268	-.24268

2d matrix identical to table C-1.

Table C-4. LR correlation matrix, 13 observations

	afqt	nation	platoon	crew	job	plr	p2r	pt	pmt	plat	ps	plrs
afqt	13.	13.	13.	13.	13.	13.	11.	13.	10.	10.	11.	11.
nation	99.00000	13.	13.	13.	13.	13.	11.	13.	10.	10.	11.	11.
platoon	.18523	99.00000	13.	13.	13.	13.	11.	13.	10.	10.	11.	11.
crew	-.22814	99.00000	.02021	13.	13.	13.	11.	13.	10.	10.	11.	11.
job	99.00000	99.00000	99.00000	99.00000	13.	13.	11.	13.	10.	10.	11.	11.
plr	-.01697	99.00000	.80678	.37280	99.00000	13.	11.	13.	10.	10.	11.	11.
p2r	-.31883	99.00000	.62131	.30705	99.00000	.62909	11.	11.	9.	9.	10.	10.
pt	-.04757	99.00000	.81632	.39461	99.00000	.97079	.76411	13.	10.	10.	11.	11.
pmt	-.33468	99.00000	.31442	.46905	99.00000	.56584	.78624	.58497	10.	10.	8.	8.
plat	-.39765	99.00000	.23911	.46129	99.00000	.51522	.73790	.51622	.99026	10.	8.	8.
ps	-.23463	99.00000	-.46985	.06932	99.00000	-.21744	-.41750	-.32627	.25786	.34591	11.	11.
plrs	-.23463	99.00000	-.46985	.06932	99.00000	-.21744	-.41750	-.32627	.25786	.34591	1.00000	11.
plr16	.03059	99.00000	.78785	.26650	99.00000	.84016	.42644	.77803	.25988	.26062	-.19541	-.19541
p2r16	-.36051	99.00000	.61237	.58333	99.00000	.76585	1.00000	.85707	.98847	.96976	99.00000	99.00000
pt16	.03390	99.00000	.80235	.33277	99.00000	.87112	.53601	.82927	.34365	.32292	-.20795	-.20795
mtlr	.11647	99.00000	-.32856	.09473	99.00000	-.26865	-.26668	-.28365	.80781	.43902	.27041	.27041
mtbr	-.05498	99.00000	-.55755	-.03840	99.00000	-.42281	-.41526	-.37289	-.32870	-.36249	.19691	.19691
minmt	.20654	99.00000	-.34308	-.36515	99.00000	-.43174	-.38020	-.42253	-.14984	-.21322	.44173	.44173
maxmt	.17307	99.00000	-.16819	.10098	99.00000	-.07797	-.14544	-.08937	.35446	.39100	.12074	.12074
minbt	.19105	99.00000	.12371	-.24442	99.00000	-.03010	-.17177	-.13954	.12832	.11381	.32142	.32142
maxbt	-.02527	99.00000	.03624	.10619	99.00000	-.08524	.16759	-.06563	.39985	.32884	.05648	.05648
plltl6	-.31493	99.00000	.36710	.57465	99.00000	.77229	.60226	.75894	.61214	.57759	.14008	.14008
p2ltl6	-.41430	99.00000	.67372	.48177	99.00000	.53676	1.00000	.70698	.75807	.72628	-.24976	-.24976
tothit	-.08795	99.00000	.65785	.48201	99.00000	.89528	.80403	.92033	.78691	.74301	-.27174	-.27174
score	-.12719	99.00000	.66078	.50441	99.00000	.89911	.76451	.91116	.67913	.66368	-.24268	-.24268

2d matrix identical to table C-1.

APPENDIX D

ASSUMPTIONS USED IN THE COMBAT SIMULATION

This appendix describes the combat conditions assumed to exist during the simulation. Almost all of the assumptions/conditions have been incorporated into the model so that they may be easily changed or modified. Therefore, the effect of these assumptions/conditions can be tested.

The Blue tank platoon is assumed to occupy its assigned general defensive position (GDP). The position is prepared with several hull defilade firing points for each tank. All Blue engagements take place from hull defilade positions. Each tank carries a basic load of 60 Armor Piercing Fin Stabilized Discarding Sabot (APFSDS) rounds. All weapon systems are functioning to specifications. Visibility exists to 2,000 meters. Engagement sequences begin at 2,000 m for both Red and Blue forces. Terrain is considered typical of that in the Fulda Gap region of the West German border.

Tank gun fire and Red anti-tank (AT) missiles are the only weapons simulated. The Blue platoon has no infantry support nor any TOW AT missiles. Red BMP 73 mm gun, Blue .50 cal M85 machine gun, small arms and artillery fire are not simulated. Once Red vehicles close within 500 meters of the Blue position, they are terminated from the model as having succeeded in assaulting the position.

The Blue platoon is confronted with a major Red breakthrough attempt. Reconnaissance forces are ignored. The Red battalion is configured to be attacking with two BMP companies in the 1st echelon. Each company is preceeded by a platoon of four attached Red main battle tanks. The 2nd echelon is comprised of the 3rd BMP company with attached tank platoon. Two ZSU-23/4's are attached. Two battalion command vehicles and the tank company commander comprise the command group. The entire attacking force consists of 13 MBT's, 30 BMP's, 2 ZSU-23/24's, and 2 battalion command vehicles for a total of 47 AFV's (Armored Fighting Vehicles).

The initial rate of advance of the Red battalion is 12 km/hr. This rate slows down as the unit closes on the Blue position. At 1,500 m the rate is 8 km/hr and at 1,000 meters becomes 4.8 km/hr. At any given time, the Red force is considered to be comprised of 50 percent moving targets. However, all Red engagements are fired from the halt. The Red are assumed to have a .6 probability of acquiring a Blue tank ONCE it has fired its main gun.

Engagements occur every 100 meters. That is, every 100 meters beginning at 2,000 meters, each Red vehicle is potentially engaged and, as well, has the opportunity to engage a Blue tank. If, however, a Red tank is not engaged within 20 seconds after acquisition, it automatically moves to the next 100 meter interval.

Each Blue tank will fire a maximum of three rounds/target. If a Red target is hit on the 1st, 2nd or 3d Rd, the Blue tank immediately relays to another Red target. If all rounds miss, the Blue tank ends the engagement of the Red target and proceeds to the next Red target. The Red vehicle advances to the next 100 meter interval where it is again placed in jeopardy. However, at each 100 meter interval it also has the opportunity to fire at the Blue tanks.

Blue tanks are exposed for only the "X" seconds and are then made unavailable for "Y" seconds. The heavy and light sections are initially staggered so that some portion of the platoon is always engaging. Blue priority is given to the closest Red MBT or ZSU-23/4. If no MBT or ZSU is available, BMP's will be engaged.

APPENDIX E

BATTLE SIM GPSS CODE

```
1               SIMULATE
                RMULT       3991
*               FUNCTIONS
*
      1 FUNCTION   RN1,D2              MOVER-1, STATIONARY-2
.7,1/1,2
*
*
 EXP   FUNCTION   RN1,C24
0,0/.1,.104/.2,.222/.3,.355/.4,.509/.5,.69
.6,.915/.7,1.2/.75,1.38/.8,1.6/.84,1.83/.88,2.12
.9,2.3/.92,2.52/.94,2.81/.95,2.99/.96,3.2/.97,3.5
.98,3.9/.99,4.6/.995,5.3/.998,6.2/.999,7/.9997,8
*
*
*
*
*
 ACQ   FUNCTION   PH1,C7              PROBABILITY OF TGT ACQUISITION BY US TANK
0,700/30,750/60,800/90,850/120,900/150,950/800,999
*
*
 ENG   FUNCTION   PH1,C5              PROBABILITY OF US ENGAGING THE TARGET
0,800/90,800/120,900/150,950/800,999
*
*
 TGTYP FUNCTION   PH3,D5
1,TYP1/2,TYP2/3,TYP1/4,TYP1/5,TYP2
*
*
 MTST1 FUNCTION   PH2,D2              DIFFERENTIATES BETWEEN MOVING AND STA TARGET
1,MOV1/2,STA1
*
*
 PHS1  FUNCTION   PH1,C4              /
0,383/150,512/375,688/800,849
*
*
 PHM1  FUNCTION   PH1,C4
0,187/150,472/375,864/800,999
*
*
 MTST2 FUNCTION   PH2,D2              AS MTST1
1,MOV2/2,STA2
*
*
 PHS2  FUNCTION   PH1,C4              /
0,393/150,527/375,706/800,883
*
*
 PHM2  FUNCTION   PH1,C4
0,191/150,484/375,649/800,794
*
*
 ROF   FUNCTION   PH1,C4              ADJUSTS RATE OF FIRE
0,5/150,5/375,5/800,3
*
*
 RNGE  FUNCTION   PH1,D4              RATE OF ADVANCE IN SECONDS
0,30/150,30/375,45/800,75
*
```

```
*
 COREL FUNCTION   PH4,D5          ASSIGNS FACILITIES TO STORAGES
1,6/2,7/3,8/4,9/5,10
*
*
 CHAIN FUNCTION   PH4,D5          ASSIGNS FACILITIES TO BMP CHAINS
1,11/2,12/3,13/4,14/5,15
*
*
 THENG FUNCTION   PH1,C3          PROBABILITY OF SOVIET ENGAGING US TANK
0,950/150,975/800,999
*
*
 SPH   FUNCTION   PH1,C4
0,147/150,235/375,380/800,573
*
*
 BMPSG FUNCTION   PH1,C4          PROBABILITY OF BMP ENGAGING US TANK
0,950/120,975/375,999/800,500
*
*
 TOF   FUNCTION   PH1,C4          TIME OF FLIGHT FOR SAGGER MISSLE
0,19/150,15/375,10/800,6
*
*
 PHSAG FUNCTION   PH1,C4
0,295/150,296/375,297/800,179
*
*
 RELAY FUNCTION   PH1,C4          TIME REQUIRED TO RELAY FROM TARGET TO TARGET
0,5/150,5/375,5/800,4
*
*
 BALK  FUNCTION   PH3,D5          ASSIGNS BALK XAC TO CORRECT USER CHAIN
1,BBB/2,CCC/3,BBB/4,BBB/5,CCC
*
*       BASIC LOAD OF AMMO PER US TANK
*
       INITIAL    XH1-XH5,60
       INITIAL    XF1-XF4,0
*
*
*       GENERATION OF SOVIET MR BATTALION REINFORCED
*       ---------------------------------------------
*
*
       GENERATE   5,4,,8,1         1ST COMPANY T-62
       ASSIGN     1,0,PH           ASSIGNS INITIAL RANGE
       ASSIGN     2,FN1,PH           "     MOVING/STA TGT MODE
       ASSIGN     3,1,PH             "     TGT TYPE (1/T62)
       ASSIGN     12,40,PH           "     BASIC LOAD OF AMMO (40 RDS-TANK)
       JOIN       TANK             PLACES TARGET IN GROUP 'TANK'
       SPLIT      1,BATL2          CNTRPART GOES TO SVT TNK COUNTERFIRE SEGMENT
       TRANSFER   ,BATL            ENTER THE BATTLE
*
*      GENERATION OF 2 BMP COMPANIES
*
       GENERATE   5,4,90,20,2      2 COMPANIES BMPS
       ASSIGN     1,0,PH
       ASSIGN     2,FN1,PH
       ASSIGN     3,2,PH           TGT TYPE(2/BMP)
       ASSIGN     12,4,PH         ASSIGNS BASIC LOAD OF MISSILES (4-BMP)
       JOIN       BMP
```

```
                SPLIT       1,BATL3          CNTRPART GOES TO BMP COUNTERFIRE SEGMENT
                TRANSFER    ,BATL
*
*       GENERATE ADA SECTION OF 2 ZSU/23-4S
*
                GENERATE     ,,120,2,1        2 ZSU/23-4
                ASSIGN      1,0,PH
                ASSIGN      2,FN1,PH
                ASSIGN      3,3,PH           TGT TYPE (3/ZSU)
                JOIN        BMP
                TRANSFER    ,BATL
*
*       GENERATION OF TANK CO CMND TANK
*
                GENERATE     ,,120,1,1        CO CMND TANK
                ASSIGN      1,0,PH
                ASSIGN      2,2,PH           STA TGT MODE
                ASSIGN      3,4,PH           TGT TYPE (4/CMND VEHICLE)
                JOIN        TANK
                TRANSFER    ,BATL
*
*       GENERATION OF BN CMND VEHICLES
*
                GENERATE    ,,120,2,3        BN CMND VEHS
                ASSIGN      1,0,PH
                ASSIGN      2,2,PH           STA TGT MODE
                ASSIGN      3,5,PH           TGT TYPE (5/BN CMND VEH)
                JOIN        BMP
                TRANSFER    ,BATL
*
*       GENERATION OF LAST T-62 PLT
*
                GENERATE    5,4,390,4,1      LAST T-62 PLT
                ASSIGN      1,0,PH
                ASSIGN      2,FN1,PH
                ASSIGN      3,1,PH
                ASSIGN      12,40,PH
                JOIN        TANK
                SPLIT       1,BATL2
                TRANSFER    ,BATL
*
*       GENERATION OF 3RD BMP COMPANY
*
                GENERATE    5,4,420,10,2     LAST BMP COMPANY
                ASSIGN      1,0,PH
                ASSIGN      2,FN1,PH
                ASSIGN      3,2,PH
                ASSIGN      12,4,PH
                SPLIT       1,BATL3
                JOIN        BMP
*
*
*       SIMULATION OF DIRECT FIRE TANK GUN ENGAGEMENTS BY US FORCES.
*       ------------------------------------------------------------
*
 BATL   ASSIGN      7,3,PH           INCREMENTS NUMBER OF ENG. FIRED PER TARGET
        TRANSFER    .FN$ACQ,MICH1,ENG  ACQUIRE TARGET
 ENG    TRANSFER    .FN$ENG,MTCH1,SEL  ENGAGE TARGET
 SEL    SELECT MIN 4PH,1,5,,0        SELECT US FIRING TANK
        QUEUE       PH4              ENTER FIRING TANKS QUEUE
        ASSIGN      5,FN$CHAIN,PH
*
*       ENGAGEMENT DECISIONS BY EACH TANK CMNDR  FOLLOWED BY
```

```
*       ACTUAL ENGAGEMENT SEQUENCE.
*
*
        MARK    SPH                 BALK PROGRAM,SEE SEGMENT "REMAINDER OF BALK P
        SPLIT   1,AAA
        EXAMINE TANK,,BMP1          IS TARGET IN TANK GROUP?
        LINK    PH4,1PH,TNK1    PLACE TARGET ON TANK TARGET CHAIN,IF YES
BMP1    LINK    PH5,1PH,TNK1    PLACE TARGET ON BMP TARGET CHAIN,IF NO
TNK1    SEIZE   PH4                 NOTE:  RANGE IS THE ORDERING PARAMETER
        DEPART  PH4
*                                   ING PARAMETER.
SHT     TRANSFER FN,TGTYP           DETERMINE TARGET TYPE.
TYP1    TRANSFER FN,MTST1               "   IF TGT IS MOVING OR STATIONARY
STA1    TRANSFER .FN$PH51,RLD,HIT1      "   PH FOR STA TGT
MOV1    TRANSFER .FN$PHM1,RLD,HIT1      "   PH FOR MOV TGT
HIT1    RELEASE PH4                 TGT HIT AND DESTROYED
        SAVEVALUE PH4-,1,XH         REDUCE FIRING TANK AMMO BY ONE RD
        ADVANCE FN$RELAY            RELAY GUN TO NEXT TARGET
        UNLINK  PH4,TNK1,1,BACK,,BMP3    UNLINK CLOSEST TANK IF AVAILABLE
        PRIORITY PR,BUFFER          HOLD UNLINKING XAC
        TEST LE PH3,2,TER1          TEST FOR BMP OR TANK
        TRANSFER .MTCH5             WAIT FOR ONTERPART FIRING AT US TANKS
BMP3    UNLINK  PH5,TNK1,1,BACK     UNLINK BMP IF TANK NOT AVAILABLE
        PRIORITY PR,BUFFER
        TEST LE PH3,2,TER1
MTCH5   MATCH   MTCH5                WAIT FOR COUNTERPART MATCH      MTCH5
TER1    TERMINATE                   TERMINATE CMND VEHS IF HIT
*
TYP2    TRANSFER FN,MTST2           DETERMINE IF TARGET IS MOV OR STA
STA2    TRANSFER .FN$PH52,RLD,HIT2      "   PH FOR STA TGT
MOV2    TRANSFER .FN$PHM2,RLD,HIT2      "   PH FOR MOV TGT
HIT2    RELEASE PH4                  BMP HIT AND DESTROYED
        SAVEVALUE PH4-,1,XH         REDUCE FIRING TANK AMMO BY 1 ROUND
        ADVANCE FN$RELAY
        UNLINK  PH4,TNK1,1,BACK,,BMP4
        PRIORITY PR,BUFFER
        TEST LE PH3,2,TER2
        TRANSFER .MTCH7
BMP4    UNLINK  PH5,TNK1,1,BACK
        PRIORITY PR,BUFFER
        TEST LE PH3,2,TER2
MTCH7   MATCH   MTCH7
TER2    TERMINATE
*
RLD     SAVEVALUE PH4-,1,XH         REDUCE AMMO BY ONE
        ASSIGN  2,FN$RLD,PH         EVALUATE RELOAD TIME
        ADVANCE PH2                 RELOAD
        ASSIGN  2-,1,PH             REDUCE FIRING RDS
        TEST E  PH2,1,NXT             TEST FOR MOVING TARGET
        ASSIGN  1+,PH2,PH           ADD RANGE TO MOVER WHILE RLDNG
NXT     TEST E  PH7,0,SHT           DOES US TANK RE-ENGAGE?
        RELEASE PH4                 IF NO,RELEASE FIRING TANK
        ADVANCE FN$RELAY            RELAY TO NEXT TARGET
*
*
*
        UNLINK  PH4,TNK1,1,BACK,,BMP2  UNLINK TANK TARGET FIRST
        PRIORITY PR,BUFFER
        TEST LE PH3,2,ADV
        TRANSFER .MTCH1                      ADVANCE TO THE NEXT ENG RANGE
BMP2    UNLINK  PH5,TNK1,1,BACK         UNLINK BMP TARGET
        PRIORITY PR,BUFFER
MTCH1   TEST LE PH3,2,ADV
```

```
MTCH3 MATCH       MTCH8
ADV   ASSIGN      10,FN$RNGE,PH              EVALUATE RATE OF ADVANCE
      ASSIGN      1+,PH10,PH                 UPDATE RANGE PARAMETER
      ADVANCE     PH10                       ADVANCE TIME
      TEST GE     PH1,750,BATL               ADV TARGET REACHED APPRX 500 METERS
      TEST LE     PH3,2,TER3
MTCH9 MATCH       MTCH9                      UNIT 5 AND TANKS WAIT FOR CNTRPART
TER3  TERMINATE
*
*     REMAINDER OF BALK PROGRAM
*
AAA   ADVANCE     20                         TARGET WAITS 20 SECONDS TO BE ENGAGED
      TRANSFER    FN,BALK                    IF NOT ENGAGED TARGET GOES TO USER CHA
BBB   UNLINK      PH4,MTCH1,1,SPH
      PRIORITY    PR,BUFFER
      TERMINATE
CCC   UNLINK      PH5,MTCH1,1,SPH
      PRIORITY    PR,BUFFER
      TERMINATE
*
*     EXPOSE FIRING TANK FOR ONLY 'X' SECONDS
*
COUNT GENERATE    ,,,5                       GENERATE 5 CONTROL XACTS
      ASSIGN      1,N$COUNT,PH
      FUNAVAIL    PH1,CO,,,,,RE,MTCH1        INITIALLY ALL US TANKS UNAVAIL
      TEST LE     PH1,3,ZZZ                  TEST FOR TANKS 4 & 5
RET   ADVANCE     10,FN$EXP                  EXPOSE TANKS 1,2,3.
      FAVAIL      PH1
XXX   GATE FV     PH1
      ADVANCE     30,3                       REMAIN EXPOSED
      FUNAVAIL    PH1,CO,,,,,RE,MTCH1        GO INTO HIDE : CANNOT FIRE
      ADVANCE     40,4                       REMAIN HIDDEN
      GATE LS     PH1,XXY                    CHECK TO INSURE US TANK NOT HIT
      TERMINATE
XXY   FAVAIL      PH1
      TRANSFER    ,XXX
ZZZ   ADVANCE     20,FN$EXP                  DELAY EXPOSURE OF TNKS 4 & 5.
      TRANSFER    ,RET
*
*     AMMUNITION CONTROL FOR US TANKS
*
COUN  GENERATE    ,,,5
      ASSIGN      1,N$COUN,PH
      TEST E      XH$PH1,0
      FUNAVAIL    PH1,RE,MTCH1,,,,RE,MTCH1
      LOGIC S     PH1
      TERMINATE
*
*
*
*
*
*     RETURN FIRE SECTION BY SOVIET MAIN BATTLE TANKS
*
*
BATL2 TEST E      PH3,1,BATL3                IS FIRING VEH A TANK OR IMP?
      SELECT FV   4PH,1,5,,F,EXIT1           SELECT FIRST AVAILABLE US TANK
      ASSIGN      5,FN$COREL,PH
      QUEUE       PH5
      ENTER       PH5
      DEPART      PH5
      TRANSFER    .4,CONTU,SVTEG             ACQUIRES TARGET (US)?
SVTEG TRANSFER    .FN$THENG,CONTU,SSHIT      ENGAGES TARGET?
```

```
SSHIT TEST E     PH2,2,LNGAQ          LONG ACQ TIME FOR MOVING TANK
      ADVANCE    10                   SHORT ACQ TIME FOR STA TANK
      TRANSFER   ,SSHT
LNGAQ ADVANCE    15                   LONG TIME TO ID TGT AND LAY GUN
SSHT  TRANSFER   .FN$SPH,,USHIT       FIRE 1ST ROUND
      ASSIGN     12-,1,PH             REDUCE AMMO BY ONE RD
      ADVANCE    17                   RELOAD
      GATE FV    PH4,CONTU            IS TARGET STILL EXPOSED
      TRANSFER   .FN$SPH,FIRE1,USHIT  YES,FIRE 2ND ROUND
USHIT LEAVE      PH5                  US TANK HIT
      ASSIGN     12-,1,PH
      FUNAVAIL   PH4                  US TANK OUT OF ACTION
      LOGIC S    PH4                  SET CORRECT LOGIC SWITCH
      TRANSFER   ,MTCH2
CONTU LEAVE      PH5
NEXT  TEST LE    PH12,0,MTCH2         IS SOVIET OUT OF AMMO? YES: TERMINATE
      TRANSFER   ,MTCH9
MTCH2 TEST E     PH3,1,OTHER          IS XAC A TANK? NO:GO TO OTHER
      GATE M     MTCH5,CHCK2          HAS CNTRPART BEEN HIT?
      TRANSFER   ,MTCH5               IF YES GO TO MTCH5 AND LINK-UP
OTHER GATE M     MTCH7,CHCK2          SAME SEQUENCE FOR BMP
      TRANSFER   ,MTCH7
CHCK2 GATE M     MTCH9,MTCH8          HAS CNTRPART REACHED 500 METERS
      TRANSFER   ,MTCH9
      TERMINATE
MTCH8 MATCH      MTCH3                WAIT ON CNTRPART IF IT HAS NOT BEEN HIT
      ASSIGN     10,FN$RNGE,PH        ADVANCE WITH COUNTERPART
      ASSIGN     1+,PH10,PH
      ADVANCE    PH10
      TEST GE    PH1,750,BATL2
      TRANSFER   ,MTCH9
      TERMINATE
*
FIRE1 LEAVE      PH5
      ASSIGN     12-,1,PH
      TRANSFER   ,NEXT
EXIT1 TRANSFER   ,MTCH2
*
      STORAGE    S6-S10,5
*
*
*
*
*     COUNTERFIRE BY SOVIET INTANTRY PERSONNEL CARRIERS ARMED WITH
*     SAGGER AT-3 MISSLES.
*
*
*
*
BATL3 SELECT FV  4PH,1,S,,F,EXIT2
      ASSIGN     5,FN$COREL,PH
      QUEUE      PH5
      ENTER      PH5
      DEPART     PH5
      TRANSFER   .4,ENDEG,BMPEN       DOES BMP ACQUIRE TARGET?
BMPEN TRANSFER   .FN$BMPAG,ENDEG,SGHIT DOES BMP ENGAGE TARGET?
SGHIT TEST E     PH2,2,LNGAC          IS BMP MOVING? IF YES, GO TO LNGAC
      ADVANCE    7
      TRANSFER   ,TOF
LNGAC ADVANCE    15                   LONG ACQUISITION TIME
TOF   ADVANCE    FN$TOF               TIME OF FLIGHT FOR AT MISSLE
      GATE FV    PH4,ENDEG            IS US TANK STILL EXPOSED
      TRANSFER   .FN$PHSAG,,SAGHIT    PH FOR AT MISSLE HIT
      ASSIGN     12-,1,PH             REDUCE MISSLE LOAD BY 1.
```

```
                LEAVE       PH5
                TEST LE      PH12,0,MTCH2
                TRANSFER    ,MTCH9
        SAGHT   LEAVE       PH5                 US TANK HIT
                ASSIGN      12-,1,PH
                FUNAVAIL    PH4                 US TANK OUT OF ACTION
                LOGIC S     PH4
                TEST LE     PH12,0,MTCH2
                TRANSFER    ,MTCH9
        ENDCG   LEAVE       PH5
                TEST LE     PH12,0,MTCH2
                TRANSFER    ,MTCH9
        EXIT2   TRANSFER    ,MTCH2
        *
        *
        *
        *
        *
                GENERATE    60
                TERMINATE   1
                START       20
                END
```

APPENDIX F

OBSERVATIONS ON INTELLIGENCE AND EDUCATION LEVELS OF U.S. TANK COMMANDERS AND GUNNERS VERSUS PERFORMANCE MADE BY CAT 1981 TEAM LEADER DURING THE TRAINING PERIOD JANUARY TO JUNE 1981 AND MAJOR GENERAL W. F. ULMER, COMMANDER, 3RD ARMORED DIVISION.

Comments by 1981 CAT Team Captain

Establishment of an Attack SOP for a CAT Battle Run:

After the first draft was developed, it was fielded to the NCO's for comment/recommendation. The response was proportional to the education/intelligence level of the NCO's. Those on the lower end of the scale had no comments or recommendations, either because they did not understand the concepts involved and did not want to publicize their lack of knowledge, or (hopefully not), they just did not care enough to get involved. This observation held true throughout the remainder of the training. Recommendations for SOP changes came from the "smarter" crewmen. These were the ones with enough perception to recognize shortcomings in our plan and tell us how to improve upon the SOP. Additionally, it was obvious throughout the training that those who understood the concepts involved and assisted in the SOP development mastered it more quickly and used it more effectively.

Boresight and Zero Procedures:

Again, the level of proficiency attained could be correlated to the intelligence/education levels of the tank commanders involved. We repeatedly had problems with the same tank commanders making procedural errors during the exercise. These tank commanders, again, were our less educated/intelligent NCO's.

Conduct of Fire:

To accomplish this (conduct of fire) quickly and accurately requires keen thought and decision making ability on the part of the tank commanders. We had some tank commanders who could not handle this, especially under the 40 second time limit of target presentation imposed by the competition.

Conclusions:

I feel experience and intelligence are the primary prerequisites to train soldiers to fight tanks effectively and to optimize the capability afforded them by their sophisticated equipment. Based on the CAT experience, if I have a choice between experience and low GT and inexperience and high GT score, I would take the latter.

A lack of education or lower intelligence scores can be overcome by a strong desire to excel and self study coupled with long hours of extra training to make up for these shortcomings. We had one TC who fell in that category and he sacrificed and worked hard to overcome his deficiencies. In my experience, he was the exception.* Rarely are these types motivated enough to sacrifice to excel. Unfortunately, they generally tend to accept their station and plod through. As systems become more complex, we must man them with people who can not only learn "how" but have the ability to understand "why."

*Underlining done by author.

COMMENTS BY MAJOR GENERAL ULMER:

Intelligence more than anything else (seniority, experience, time in service, crew stability) is the discriminator between good and outstanding tank gunnery performance where multiple target engagements under the stress of time are the primary concern. (I would be very reluctant to enter a crew into the final training phase for CAT '83 where the combined GT score of TC and gunner was less than 220).* Screening of individiual crewman for intelligence, visual acquity, and hand-eye coordination should be the first step in forming the CAT team.

*Requires an average of MC II for the gunner and tank commander.